



Fertilizing Fruit Crops

Apples

Pears

Peaches

Plums

Cherries

Grapes

Strawberries

Raspberries

Blackberries

Blueberries

Cooperative Extension Service
The Ohio State University

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The Authors—

Eldon S. Banta, Extension horticulturist,
The Ohio State University.

Robert G. Hill, Jr., professor of horticulture,
Ohio Agricultural Experiment Station.

James M. Beattie, assistant director and professor of
horticulture, Ohio Agricultural Experiment Station.

Fertilizing Fruit Crops

Fruit plants, like others, require ample supplies of all essential plant nutrient elements. The soils of suitable fruit sites in Ohio are more frequently limited in the supply of nitrogen than of any other element. Hence, in many instances only nitrogen need be applied. For these reasons, fertilizer recommendations for fruit crops are generally given in terms of the nitrogen needs. This does not mean that if other elements in the soil are insufficient for good growth and production they need not be applied. Phosphorus, potassium, magnesium or manganese and boron should be applied when needed.

Excessive applications of any nutrient element, including nitrogen, can cause serious difficulties. For example, under certain circumstances a heavy application of potassium could result in a deficiency of magnesium; or, a heavy application of magnesium may cause a potassium deficiency. Nitrogen applied at excessive rates can result in fruits of poor color, flavor and keeping qualities, and trees with low degree of winter hardiness.

Fertilizer Requirements Vary

Although soil fertility levels and fertilizer practices are of major importance, they do not offer the total answer to successful fruit growing. The performance of the fruit plant is dependent upon many factors. Even with proper fertilization, unsatisfactory production may be experienced due to mechanical injury, poor pest control, unsatisfactory site selection or improper cultural practices.

The soils of different sites vary in productivity due to previous treatments, native fertility and physical properties. This means that any fertilizer recommendations must be given in general terms. The only real guide to precise nutritional needs of a fruit plant is an intimate knowledge of the plant itself—how it grows, its appearance and chemical composition.

FOLIAR ANALYSIS

A chemical analysis of leaves, or any other plant part, can give the percentage content of several nutrient elements. With most horticultural crops, leaves or leaf petioles have been most frequently used for chemical-analysis studies.

Accurate chemical analysis (foliar analysis) of leaf samples, properly collected and treated, can be a basis for improving the cultural program in fruit plantings. The results, properly interpreted, can be of great value in adjusting the fertilizer program in a given fruit planting. Such adjustments may result in more efficient use of fertilizers and increased production of quality fruits.

To be of greatest value, a foliar-analysis program should be planned for a period of years. A single analysis may indicate the chemical status in the plants at the time sampled, but it does not indicate what the status may be a year later. Thus, it becomes necessary to sample a given planting annually for a period of at least three to five years in order to establish trends and changes in nutrient-element levels in a particular planting. Nutrient-element levels in the plant will change from time to time according to the fertilizers applied, soil pH, soil-moisture level and availability, soil and air temperatures, and the load of fruit on the plants.

Foliar analyses can be of value in diagnosing the cause or causes of some abnormalities in plant growth or fruit development. On occasion only a single analysis may be needed. In other instances, a series of analyses may be necessary to arrive at a proper explanation.

Foliar analyses, particularly if they are made over a period of years, can indicate an approaching deficiency of a nutrient element before the plant shows any visible symptoms. Thus, it is possible through proper application of the element, to prevent its deficiency ever occurring in the plant. By the same token, it is possible to learn when an element may be increasing in the plant towards a level that will reduce fruit quality or bring about some other undesirable result. When this condition is known, steps can be taken to alter the fertilizer program and cultural practices that influence the uptake of the element from the soil solution.

It is necessary to have as much information as possible about the growth characteristics of the plants sampled if accurate interpretations of results are to be made. The analysis data alone are inadequate for determining changes in the fertilizer program. The information sheet that accompanies a leaf sample for analysis may be as important to the interpreter as the analysis itself.

In the early summer of 1964, the Ohio Cooperative Extension Service, in cooperation with The Ohio Agricultural Experiment Station, initiated a Foliar Analysis Program. This service is now available on a fee basis to fruit growers and other crop producers in Ohio. County Extension offices have detailed information on this program. Interpretation of the results and the recommendations for fertilizer applications, or other changes in cultural practices, are being made by qualified Experiment Station personnel.

SOIL ANALYSIS

Soil analysis has limited value in determining fertilizer needs for fruit crops. It gives the relative amounts of certain elements available in the soil, but no indication of the level of these elements within the plant. For fruit crops, a poor correlation frequently exists between a soil test and a leaf analysis for a given element. This does not necessarily rule out the use of soil testing as a basic tool in determining fertilizer needs for fruit crops. In addition to the level of availability of certain nutrient elements, a soil test gives the pH, or degree of acidity or alkalinity, and the level of soluble salts in the soil. This information is helpful in determining fertilizer practices as well as the need for lime. A soil analysis has greater value when used in conjunction with a foliar analysis. A soil-analysis service is available through each County Cooperative Extension Office.

KINDS OF FERTILIZER

Inorganic Fertilizers

Inorganic fertilizers may contain only one essential plant nutrient, or a mixture. The label on the product states the percentages of nitrogen (N), phosphorus (P_2O_5) and potassium (K_2O) the material contains. Thus, the analysis on a bag of mixed fertilizer may read, 10-6-4, which means that it contains 10% nitrogen, 6% phosphorus pentoxide (P_2O_5) and 4% potassium oxide (K_2O). The percentages are always in this order in the analysis formula.

Inorganic fertilizers may be purchased and used separately, as well as in mixtures. Nitrogen is commonly available in these forms: nitrate of soda (16% nitrogen), sulfate of ammonia (20% nitrogen), ammonium nitrate (33% nitrogen), urea (45% nitrogen) and anhydrous ammonia (82% nitrogen). Phosphorus can be purchased as superphosphate (20% or 45% P_2O_5) and potassium as either sulfate of potash (50% K_2O) or muriate of potash (60% K_2O). Inorganic fertilizers are usually the most economical sources of nutrient elements.

Organic Fertilizers

The term organic fertilizer is commonly applied to plant or animal materials or waste products which contain one or more of the nutrient elements. These include materials, such as straw, hay, grass clippings, corn cobs, sawdust, bone meal, blood meal, tankage, and animal manures. The natural processes of decay must take place in order to release the nutrient elements in the soil. Consequently, nutrients in organic fertilizers are generally more slowly released than those of inorganic materials. In the case of sawdust, it may take several years, while alfalfa hay or bone meal may take only a few weeks or months to break down.

Average Nitrogen Content of Certain Organic Materials

Organic Material	Nitrogen (N) average lbs. per Ton	Pounds of actual N needed to bring the N content to 2% per ton
	lbs.	lbs.
Wheat Straw	12.2	27.8
Corn Cobs	7.4	32.6
Peanut Hulls	21.4	18.6
Sweet Clover Hay (damaged)	36.0	4.0
Peat Moss	20.0 (est. 1%)	20.0
Wood Chips (oak)	4.0	36.0
Sawdust	9.0	31.0
Bone Meal (raw)	60.0	
Cottonseed Meal	120.0	
Fish Meal	200.0	

An organic material may vary considerably in composition, depending upon its source. Thus, when such a material is applied as fertilizer, an unknown quantity of nitrogen, phosphorus, potassium or other elements is actually applied. Organic materials do have certain advantages, but price per unit of plant food is not one of these advantages.

It must be remembered that plant roots absorb various elements only in certain forms, regardless of whether supplied as organic or inorganic material. For example, nitrogen enters the root in either the nitrate or the ammonium form, whether it comes from inorganic commercial fertilizer, manure or other sources.

SOIL MANAGEMENT AFFECTS FERTILIZER NEEDS

The soil management system maintained in a fruit planting will determine, in part, the fertilization practices followed. Fruit crops are grown under one of three systems of soil management: (1) cultivation or cultivation plus cover crops; (2) permanent sod cover; or (3) sod cover plus mulch around the trees or plants.

In general, fruit crops grown under cultivation (1) require lower rates of nitrogen application than when grown under the sod cover (2, 3). A sod crop growing in the planting will remove nitrogen and other elements from the soil in its growing processes. Thus, higher rates of nitrogen are often needed.

Fruit crops grown under an established mulch system (3) require lighter rates of nitrogen application than under a newly established mulch. This results from the mulch material releasing nitrogen into the soil as it decays. Mulch materials, such as hay, straw and corn cobs, may also differentially affect the uptake of potassium, phosphorus and possibly other elements.

LIMING SOILS

The chemical reaction of a soil may be termed acid (sour), neutral, or alkaline (sweet). Soil acidity or alkalinity is measured by the pH scale. The neutral point is a pH of 7.0. Below this, such as pH 5.0, the scale indicates an acid condition, and above, as pH 8.0, an alkaline condition. Due to the scale used, each whole point is ten times greater than the one preceding it. Thus, a pH 5.0 is ten times more acid than pH 6.0; or, a pH 8.5 is ten times more alkaline than pH 7.5.

For best growth and production of most fruit plants, the soil pH should be between 5.5 and 6.8. This range is also desirable for good cover crop development. One exception is the blueberry which does best on acid soils in the pH range of 4.0 to 5.5.

Liming materials are applied to acid soils to counteract the acidity and thus provide a more favorable environment for growth of plant roots and soil micro-organisms. Liming may also aid in releasing more nitrogen, phosphorus and other nutrient elements from the soil complex, thus making them more available to plant roots. Liming materials may benefit some soils by supplying two essential elements—calcium and magnesium.

Different kinds of liming materials are commercially available. Agricultural ground limestone is the one most frequently used. It is high in calcium carbonate, the acid neutralizing factor. Dolomitic limestone contains two neutralizing chemicals, namely calcium carbonate and magnesium carbonate. It has a somewhat greater neutralizing power than does ordinary agricultural ground limestone, and supplies much greater amounts of magnesium. This form of lime is preferred where magnesium is needed. Hydrated lime may also be used to correct soil acidity. Its neutralizing power is about twice as great as that of agricultural limestone.

Regardless of the kind of liming material, the more finely it is ground, the more effective it will be in raising soil pH. The following table gives the comparative neutralizing power of various liming materials. Recommendations are generally given in pounds or tons of agricultural limestone needed to make the proper correction.

When the amount of lime needed is four or more tons per acre, it is best to apply it in split applications. From three to four tons may be applied in the initial application and the remainder a year or so later.

The indiscriminate use of lime should be avoided. Applications should only be made after a soil test has established that it is needed and then only in the recommended amounts. Unnecessary use of lime is not only costly but it can be detrimental to the nutritional status of the planting. Under high lime, or high pH conditions (above 7.0) certain nutrient elements, such as iron, boron and manganese, are rendered insoluble and unavailable to plant roots.

Comparative Neutralizing Power of Liming Materials*

Material with 90 or More Total Neutralizing Power	Total Neutralizing Power (TNP)	Per Cent Passing Through No. 100 Sieve	Pounds of Material to Equal one Ton of Agricultural Ground Limestone
Limestone:			
Coarse Meal	90 +	20-29	2600
Fine Meal	90 +	30-39	2400
Agricultural Ground Limestone	90 +	40-59	2000
Pulverized	90 +	60-79	1700
Super Fine	90 +	80-100	1600
Hydrated Lime	130	100	1200
Hydrated Lime	160	100	1000
Agricultural Granulated Slag (water cooled)	90	* 55-60	2000

* Any liming material may be applied whenever soil conditions are suitable for spreading. On very acid soils it will require at least six months for the lime to cause any appreciable change in the soil pH. The more thoroughly the lime is mixed with the soil, the quicker will be its neutralizing effects.

* * Percent passing through a 20-mesh sieve.

TIME AND METHOD OF FERTILIZATION

Granular Fertilizers

Early spring applications of nitrogen fertilizers, before new growth begins, are considered most satisfactory. For tree fruits, nitrogen should be applied at least 30 days before the average bloom date.

In the case of apples and pears, nitrogen fertilizers may be applied in **late November or December** equally as well. Summer or early fall applications or nitrogen to any of the tree fruits are not advisable. This may cause poor fruit over-color, late growth and decreased winter hardiness of wood and buds. Avoid getting granular fertilizers on vegetative parts of plants as injury may result. If the material is applied over foliage, it should be brushed or washed off immediately.

Elements other than nitrogen, such as phosphorus, potassium or magnesium, may be applied anytime of the year without causing any ill effects on the plants. It is generally convenient to apply them with the nitrogen.

Incorporation of fertilizer materials into the soil will result in more rapid availability to the plants. This is especially true of the elements other than nitrogen. This may not be practical in some fruit plantings under the sod-management system.

Fertilizers, for most efficient use, should be broadcast over the root area of the crop. In case of tree fruits this corresponds rather closely with the spread of branches. In small-fruit plantings and vineyards this same principle holds true, but it is often more convenient to broadcast the fertilizer over the entire area. If rows are rather close together, the plant roots will extend into the between-row areas.

Care should be exercised to assure applying the proper amount of fertilizer. In small plantings the required amounts are frequently applied by spreading the material beneath the drip of the branches or within the row area by hand. In larger plantings, different types of mechanical spreaders are used. Either mode of application is satisfactory. When spreaders are



In small strawberry plantings, fertilizer can be spread in a circle over the root area of each plant. In larger plantings, it is easier to broadcast the fertilizer over the entire area.

used it is important that they be calibrated on the basis of the amount of fertilizer applied beneath the drip of the branches or within the row area rather than on the amount applied per acre of orchard.

Foliar Sprays

Foliar applications of certain nutrient elements may be made to some fruit crops, especially apples and grapes. It is impractical, however, to supply the entire requirement for nitrogen in foliar sprays and consequently these should generally be considered as supplemental to regular soil applications. The same principle holds true for most other nutrient elements. Where nitrogen is applied as a foliage spray to apple trees it is generally done with



Using a mechanical fertilizer spreader in larger fruit plantings is more efficient than making hand applications around each plant. In many instances, the root systems extend into the area between the rows.

a mixture of 5 pounds of urea per 100 gallons of water. Peach trees and other stone fruits respond poorly to foliage sprays of nitrogen.

In some instances, deficiencies of magnesium, manganese or boron may be temporarily corrected by annual foliage applications of these elements. Where magnesium is deficient, several spray applications during the growing season may be necessary. It is rarely economical to apply phosphorus or potassium to fruit crops through foliar sprays.

RATE OF FERTILIZATION

Fertilizer recommendations for Ohio are presented for both tree fruits and small fruits. These recommendations should be adjusted by the grower from time to time, according to the growth and fruiting characteristics of the plants and a yearly leaf analysis program. Through such a program, excessive rates of nitrogen application can be avoided. They may cause succulent growth late in the season that may be susceptible to low-temperature injury during the winter. This is particularly true of peaches and other stone-fruit trees.

In adjusting these recommendations, observe the amount of terminal growth, productivity and foliage color of the plants in question. In general,

FERTILIZER RECOMMENDATIONS

Tree Fruits*

Kind of Fruit	Material and Rate of Application ⁽¹⁾	Placement	Remarks
Apple	Basic rate of application is ¼ pound of a 16% nitrogen carrier per tree per yr. of tree age ⁽²⁾ or its equivalent.	Spread beneath drip of branches in early spring but keep at least a foot from trunk on mature tree.	Excessive nitrogen may reduce the red over-color of apples.
Pear	Apply ¼ lb. of nitrate of soda (16% N) per tree per year of tree age; apply every other year. ⁽²⁾	Same.	Excessive nitrogen is associated with an increased incidence of fire blight.
Peach	Basic rate of application is ¼ lb. of 16% nitrogen carrier per tree per yr. of tree age ⁽²⁾ or its equivalent.	Same.	If stone fruit trees are in sod, double the rate of nitrogen.
Plum Cherry Apricot	These three stone fruits are fertilized similar to peach trees.	Same.	Same as for peaches.
All Tree Fruits	Potassium: Apply at rate of ¼ lb. of muriate or sulfate of potash per tree per year of age, but not over 4 lbs. to any one tree per application.	Same	Apply potassium only when needed, as indicated by soil test or leaf analysis.
All Tree Fruits	Other fertilizer elements should be applied at rates according to leaf analyses and/or soil tests; or when deficiency symptoms begin to appear.		

⁽¹⁾ Rates are given in terms of 16% nitrogen carrying fertilizer. An equivalent amount of nitrogen in any other carrier is as satisfactory. To calculate the proper amount of other fertilizer needed to apply the equivalent amount of nitrogen in pounds, simply divide 4 by the percent of nitrogen in that fertilizer.

Examples: A. If a 20% nitrogen carrier is used:

$$\frac{4}{20} = \frac{1}{5} \text{ pound of } 20\% = \frac{1}{4} \text{ pound of } 16\%.$$

B. If a 12% nitrogen carrier is used:

$$\frac{4}{12} = \frac{1}{3} \text{ pound of } 12\% = \frac{1}{4} \text{ pound of } 16\%.$$

⁽²⁾ If the age of a tree is unknown, the following general rule may be used for most tree fruits. Apply ¼ pound of a 16% nitrogen carrier per tree per inch of trunk diameter one foot from the ground. Thus, an 8-inch tree would receive 2 pounds.

* The rates are for standard size trees. For semi-dwarf trees the same rates apply for trees up to about 12 years of age. The amount may be reduced somewhat on mature bearing trees, the maximum being equivalent to 4 or 5 pounds of a 16% nitrogen carrier per tree. On mature dwarf trees (8 years and older), the maximum amount may be from 3 to 5 pounds per tree, depending upon tree size.

FERTILIZER RECOMMENDATIONS

Small Fruits

Kind of Fruit	Materials and Rate of Application	Placement	Remarks
Grapes	In early spring, apply nitrogen carrying fertilizer to give 40 to 60 pounds actual nitrogen per acre.	Broadcast over row and between row areas.	Grapes should be watched for development of deficiencies such as potassium and magnesium. An excess of one may cause a deficiency of the other
	For small plantings: ¼ pound of a 33% nitrogen carrier per vine, or its equivalent.	Apply in a 4-ft. diam. circle around each vine.	
Strawberries	New planting: Apply 400 to 500 pounds of 5-10-10 fertilizer per acre, or its equivalent; or 10 to 12 pounds per 1000 square feet.	Broadcast over entire area.	Apply during site preparation and incorporate before setting plants.
	At renewal: Apply ammonium nitrate at 100 to 125 pounds per acre; or 1½ pounds per 100 feet of row.	Broadcast over row area.	
Raspberries	200 pounds of 16% nitrogen carrier per acre, or its equivalent; or 3½ pounds per 100 feet of row.	Broadcast in row area.	Apply in spring before growth starts.
Blackberries	200 pounds of 16% nitrogen carrier per acre, or its equivalent; or 3½ pounds per 100 feet of row.	Broadcast in row area.	Same.
Blueberries	¼ to ½ pound of sulfate of ammonia around each plant. (If iron chlorosis develops, apply iron chelate according to directions on the bag.)	Broadcast in row area.	Same.
Currants and Gooseberries	½ pound of 16% nitrogen carrier per plant, or its equivalent.	Broadcast in row area.	Same.

as long as foliage is of moderate, dark-green color, yield and over-color of fruits are satisfactory, and annual terminal growth is between 6 and 12 inches, there is little need for immediate or drastic changes in the fertilizer program of fruit trees. Nonbearing trees are growing satisfactorily if annual terminal growth is between 15 and 30 inches, with the exception of pears, which should make only 12 to 16 inches in order to reduce blight susceptibility.

The following Index for Judging the Nitrogen Status of Fruit Trees will aid in visual determination of the nitrogen needs of various fruit trees. In evaluating the nitrogen status of fruit crops, growers are cautioned to be alert to the fact that physical injury to the trees, or disease or insect damage may result in apparent symptoms of deficiency.

INDEX FOR JUDGING NITROGEN STATUS OF FRUIT TREES

Foliar Analyses and Observed Appearance

Index Point	Low Nitrogen	Normal Nitrogen	Excessive Nitrogen
Percent Nitrogen ⁽¹⁾ in leaves	Below 1.9%.	Apple Trees Only 1.9 to 2.4%	Above 2.5%.
Terminal Shoot Growth	Bearing—Small diameter, less than 4" in ave. length.	Ave. 4-12 in. long.	Ave. 12-20 in.
	Non-bearing—Less than 10" in ave. length.	Ave. 10-24 in. long.	Ave. 24-40 in.
Leaf Size	Small, thin.	Medium to average. All Fruits	Large, thick; often puckering at tip.
Leaf Color	Uniformly pale yellowish-green.	Normal green.	Very dark green.
Fall Leaf Drop	Early; leaves show some red coloration in veins.	Normal time; leaves green to light green.	Late; leaves remain dark green until severe frost.
Bark Color	Light brown to reddish brown.	Gray to dark gray-brown	Greenish gray to gray.
Fruit Set	Poor; June drop of young fruit usually heavy.	Normal for the variety, or average of 1 to 3 fruits set per cluster.	May have little or no effect; or may reduce set somewhat.
Fruit Size	Per tree average is smaller than normal.	Normal for the variety.	Per tree average is larger than normal.
Fruit Overcolor	Highly colored; often earlier than normal.	Average color for the variety at picking time.	Poor color up to and after normal picking period.
Fruit Undercolor	Yellow color develops earlier than normal for the variety.	Yellow-green to yellow color develops normally for the variety.	Green to greenish-yellow color at normal picking period for the variety.
Fruit Maturity	Somewhat earlier than normal for the variety.	Normal picking dates for the variety.	Later than normal for the variety by 5 to 10 days.

⁽¹⁾ The percentage values for nitrogen may vary somewhat from variety to variety, particularly as to the excessive level and its influence upon fruit color development.



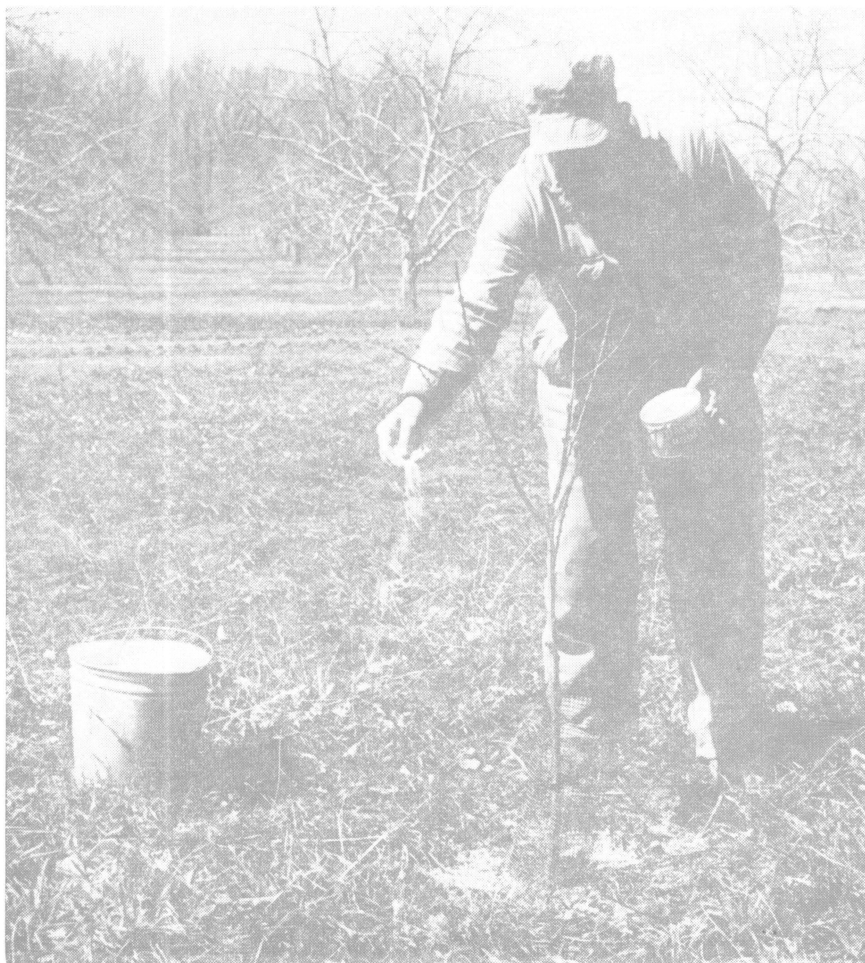
In established, mature orchards, trees frequently can be fertilized by hand using the broadcast method. Applications can be confined to the area directly under the branches of each tree.

FERTILIZING NEWLY SET TREES

Trees set in the fall should be fertilized the following spring about the time growth begins. Spring-set trees may be fertilized a month after planting. The fertilizer should be scattered in a ring about a foot away from the tree trunk. Nitrogen is generally the only element needed at this time. It should be applied at the rate of 2 to 3 ounces of a 16% nitrogen carrier per tree, or its equivalent.

Starter solutions applied at planting time have given variable results with fruit trees. Generally, they have not proved themselves on the more fertile soils. On very poor soils and very light sandy soils, starter solutions may be of some value.

On very acid soils, some benefit may be gained by applying a solution of hydrated lime around each tree immediately after planting. A suggested mixture is 2 pounds of hydrated lime in 5 gallons of water per tree. This may be of special benefit to young Red Delicious trees planted on acid soils below a pH of 5.5. Such applications at planting time may reduce or prevent the appearance of "apple measles" (internal bark necrosis) for a few years at least.



Apply fertilizer to newly set trees in a ring about a foot away from the trunk. In most instances, nitrogen is the only fertilizer element needed at the time of planting.

Thanks to—

Freeman S. Howlett, chairman, Department of Horticulture and Forestry, The Ohio State University; and Department of Horticulture, Ohio State
Garth A. Cahoon, associate professor, Department of Horticulture, Ohio Agricultural Experiment Station.

for their contributions in preparing the manuscript for this bulletin.

2/65-5M

The Ohio State University cooperating with the U. S. Department of Agriculture.
Cooperative Extension Service, Roy M. Kottman, Director, Columbus, Ohio 43210.
Printed and distributed in furtherance of Acts of May 8 and June 30, 1914